

that applies as much to himself as it does to his favored classics: "First, it seems pleasant to examine the foundations from which the sciences have been raised to their present height. Second, it will be of some interest to sample the sources from which virtually all the discoveries of the moderns are derived."

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## Mathematics after Newton

**The Development of Newtonian Calculus in Britain, 1700–1800.** NICCOLÒ GUICCIARDINI. Cambridge University Press, New York, 1990. xii, 228 pp., illus. \$54.50.

Guicciardini here aims to qualify the traditional view that British mathematics "declined" in the century after Newton, slipping from the creative leadership associated with such names as Wallis, Barrow, Gregory, and Taylor to the point, early in the 19th century, when few, if any, in England could follow the mathematical papers routinely presented to the French Academy of Sciences. To convey a more accurate appreciation of what happened after Newton, Guicciardini surveys the British mathematical community over the 18th century, dividing the period into three main segments. During the first three decades, Cotes, Taylor, and Stirling transformed Newton's sketchy presentations of fluxions into a system of mathematics and Berkeley dissected its conceptual foundations. From the mid-'30s to the mid-'80s textbook writers conveyed the subject with an emphasis on application rather than on theory. Writers admired Maclaurin's painstakingly rigorous *Treatise of Fluxions* (1742) as a definitive response to Berkeley, but they did not emulate it. Nor could others follow Maclaurin's lead in applying fluxions to such problems as the attraction of ellipsoids. Some writers did begin at this time to explore fluxions as a form of symbolic algebra, the "analytic art," laying the groundwork for the period of gradual reform that Guicciardini dates from 1785 to 1809 and follows at the Scottish universities, the military schools, and Dublin and Cambridge.

Given Guicciardini's broad focus, much of the book consists of capsule biographies and brief characterizations of the mathematical literature and of the institutions where mathematics was taught. He leaves the details to the primary and secondary literature cited in the ample bibliography. Curiously, the evidence he does present and the conclusions he draws from it often tend to

reinforce the traditional view he is trying to refute. Fluxions did not lead as easily as differentials to such important concepts as partial derivatives and partial differential equations; notation did make a difference. British mathematicians did, on the whole, prefer a geometrical approach to their subject, including in geometry an intuitive concept of motion through space over time. The many textbooks published dealt largely with elementary material, conserving rather than raising the low level of mathematical education. Despite the promises of curricula and published lectures, not much mathematics was either taught or learned in British universities and military schools, the latter of which catered to boys in their early teens. As impressive as Maclaurin's or Simpson's work may have been in its own right, it had no influence on the development of mathematics.

Indeed, in the last chapter Guicciardini brings out an irony of the "reform" that offers a measure of the decline it was meant to reverse. Trained to think in terms of series and fluxions, the Cambridge analysts embraced Lagrange's algebraic version of the calculus, which treated differentiation as an operation and identified derivatives with the coefficients of series expansions of functions. As outside observers of Continental mathematics, they did not see the new directions in which Cauchy's work was taking analysis. Hence, while the Lagrangian view steered Babbage and others to interesting new work in the calculus of operators and functional analysis, it diverted their attention from the mainstream that flowed toward Weierstrass, Cantor, and Dedekind. Though not in isolation, British mathematics would follow its own course during much of the 19th century as well.

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## Evolutionary Themes

**Population Biology of Genes and Molecules.** NAOYUKI TAKAHATA and JAMES F. CROW, Eds. Baifukan, Tokyo, 1990. xii, 370 pp., illus. ¥9,270. From a symposium, Tokyo, Dec. 1988.

It is somewhat unfortunate that the name of Motoo Kimura has become synonymous with the neutral theory of molecular evolution in the minds of many biologists. Kimura is rightly given credit for much of the current structure of the neutral theory, which has had an enormous impact on modern biology (for example, molecular biologists constructing consensus sequences are in effect applying the neutral-theory re-

sult that regions under the most selection evolve the most slowly). What is unfortunate is that biologists are ignorant of Kimura's other major contributions to population genetics. Indeed, models introduced as alternatives to the neutral theory often rely on methods of analysis introduced by him. His influence on quantitative genetics and on the study of genome evolution, population structure, and molecular evolution is apparent in *Population Biology of Genes and Molecules*, a collection of 21 papers presented on the occasion of Kimura's being awarded the Fourth International Prize for Biology. (He is the first Japanese biologist to win this major award, established in 1985 by Emperor Hirohito, himself a renowned biologist.) I found the papers uniformly interesting, although they are mainly reviews of previous work rather than new material. There is a roughly equal mix of theoretical and empirical work, and this collection serves as a nice introduction to much of current population genetics.

The quantitative genetics papers in this volume by Hill, Tachida and Cockerham, and the recently deceased Terumi Mukai testify to Kimura's influence on this field. Kimura's results on the fixation probability of a selected allele were used by Robertson in his landmark 1960 paper on the expected selection limit in artificially selected populations. Likewise, Kimura developed the first detailed model specifying the amount of genetic variability maintained in a quantitative character by mutation and selection. This is currently a major growth area for theoreticians. As reflected in the papers by Ohta, Watterson, and Yamazaki, the neutral theory underpins much of current theories of the evolution of genomic structures such as mobile elements and tandem arrays.

An especially interesting paper is by Provine, who traces the historical development of the neutral theory. Though genetic drift is a major component of Sewall Wright's shifting-balance theory of evolution as well as in Kimura's development of the neutral theory, Provine notes a critical distinction between the role of drift in the two theories. Wright did not view drift, by itself, as an important evolutionary process. Rather, he envisioned it as a process for generating genetic combinations to be acted on by selection. Although Wright acknowledged the presence of neutral alleles, he was more concerned with alleles having direct physiological effects on some aspect of the phenotype. Conversely, Kimura viewed drift itself as a major evolutionary force, especially when considering evolution at the level of individual nucleotides. Thus, whereas Wright's theory deals with evolution at the phenotypic level, Kimura's deals

with evolution at the molecular level. Provine adds that much of the initial negative reaction to the neutral theory resulted from the deep-seated assumption that molecular evolution is a reflection of phenotypic evolution, a confusion that to some extent exists today. What the neutral theory argues is the opposite—these two levels of evolution are largely independent, making it difficult to extrapolate from phenotypic evolution to evolution at the molecular level. Provine concludes that the neutral theory bifurcates the study of evolution into separate disciplines, molecular and phenotypic. This pessimistic view may indeed be largely correct, at least until we have a much deeper understanding of developmental genetics. Ironically, it may be the fruits of Kimura's contributions to the enterprise (quantitative genetics) that tenuously connects these disciplines that will reunify them.

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## The Assembly of Pangea

**Evolution of Laurussia.** A Study in Late Paleozoic Plate Tectonics. PETER A. ZIEGLER. Published for the Royal Geological and Mining Society of The Netherlands by Kluwer, Norwell, MA, 1989. x, 102 pp., illus., + plates. \$69. International Lithosphere Programme Designated Publication no. 0163.

This book is one of a new generation representing a distinctive approach to the interpretation of earth history. Maps are used to show how continents, island arcs, and other objects have moved across the surface of the earth through geologic time. The maps incorporate information about changes in the extent of the seas over the continents, where and when mountains were built, and very much more. Not only are an understanding of plate tectonics and the use of paleolatitudinal indicators essential to construction of the maps, a wealth of diverse information from the archives of historical geology is also required. The models embodied in the maps can be tested because they must be tectonically and environmentally consistent not only in space but also as they evolve through time.

Ziegler has already published two books giving sequences of maps. In this volume he turns his attention to the 150-million-year interval between the end of the Silurian and the end of Permian times, during which the supercontinent of Pangea was assembled by successive collisions: first between much of Europe and North America to make "Lau-

ruссия," and then between Laurussia and Gondwana. After a final episode joining Siberia and Kazakhstan to Laurussia, Pangea remained largely in one piece for about 100 million years. Many critical events in the assembly of Pangea took place within or on the borders of Europe, extending into the Ural mountains and the Arctic in one direction and the Appalachians in the other, so that a European perspective such as Ziegler's is essential.

There are eight main chapters, an introduction, and a final discussion. The chapters relate to eight colored, fold-out maps (whose publication was subsidized by Shell International Petroleum) that show the progress of Pangea's assembly between 410 and 250 million years ago in areas that are now mainly in North America, Europe, and the Arctic. There is also a less detailed set of ten maps for the entire Western Hemisphere (the other hemisphere was largely oceanic and has left little record).

The way to use the book is to fold out a map while reading the corresponding chapter. The text is condensed, but Ziegler has been generous in citing references, devoting 78 pages to text and 23 to references. Features of the synthesis that particularly impressed me included 800-kilometer anticlockwise motion of Europe with respect to North America and Greenland over the 60 million years that followed the closing of an ocean on the site of the Northern Appalachian and Caledonian mountains and the perhaps related opening and closing of a small ocean basin extending from Brittany to Poland over about the same interval. The evolution of this basin and the mountain building and collapse that followed its closure constitute the "Hercynian"—a mountain-forming event long considered enigmatic because it was thought to be unlike modern mountain-building episodes. Ziegler's approach confirms that the Hercynian mountains can be understood as products of the kinds of processes operating today.

Those who wish to go further in looking at questions raised by Ziegler's syntheses will need the local stratigraphic charts characterizing discrete time intervals, which are the essential building blocks for a study of this kind. Without them the reader cannot assess the exact evidence on which particular inferences have been based; however, publication of these charts would have produced a much larger and more expensive book.

I found the European material most comprehensive. It is the peripheral areas, Africa, Asia, and the Arctic, that seem to offer the clearest opportunities for further work. One topic, for example, that warrants attention is a thick wedge of sediment in Libya and Tunisia representing material eroded from

the Hercynian mountains during the latest Paleozoic. This basin is of more than local interest because it has sometimes been suggested that erosion of the Hercynian mountains yielded little sediment.

*Evolution of Laurussia* represents progress in synthesizing what happened during a dramatic interval in the earth's history but, as the author stresses in a postscript, also serves to identify further challenges.

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## Books Received

**Agricultural and Synthetic Polymers.** Biodegradability and Utilization. J. Edward Glass and Graham Swift, Eds. American Chemical Society, Washington, DC, 1990. xii, 323 pp., illus. \$69.96. ACS Symposium Series; 433. From a symposium, Dallas, April 1989.

**The Amateur Astronomer.** Patrick Moore. Norton, New York, 1990. vi, 337 pp., illus. \$35.

**Analytical Chemistry of *Bacillus thuringiensis*.** Leslie A. Hickle and William L. Fitch, Eds. American Chemical Society, Washington, DC, 1990. x, 149 pp., illus. \$34.95. ACS Symposium Series; 432. From a symposium, Miami Beach, FL, Sept. 1989.

**Animal Rights Vs. Nature.** Walter E. Howard. Published by the author, 24 College Park, Davis, CA, 95616, 1990. xii, 226 pp., illus. Paper, \$10.

**The Anthropology of Numbers.** Thomas Crump. Cambridge University Press, New York, 1990. x, 201 pp., illus. \$49.50. Cambridge Studies in Social Anthropology.

**Arch Dams.** J. Laginha Serafim and R. W. Clough, Eds. Balkema, Brookfield, VT, 1990. xvi, 559 pp., illus. \$95. From a workshop, Coimbra, Portugal, April 1987.

**Arms and the Enlisted Woman.** Judith Hicks Stiehm. Temple University Press, Philadelphia, 1989. x, 331 pp., illus. \$29.95.

**Brainstem Mechanisms of Behavior.** W. R. Klemm and Robert P. Vertes, Eds. Wiley-Interscience, New York, 1990. xii, 595 pp., illus. \$99.50.

**Calcium as an Intracellular Messenger in Eucaryotic Microbes.** Danton H. O'Day, Ed. American Society for Microbiology, Washington, DC, 1990. xiv, 418 pp., illus. \$72; to ASM members, \$54.

**Causality in Sociological Research.** Jakub Karpiński. Kluwer, Boston, 1990. xii, 174 pp., illus. \$54. Synthese Library. Studies in Epistemology, Logic, Methodology, and Philosophy of Science, vol. 212. Translated from the Polish edition (Warsaw, 1985).

**Conversations on the Plurality of Worlds.** Bernard le Bovier de Fontenelle. University of California Press, Berkeley, 1990. 1, 82 pp. \$24.95; paper, \$7.95. Translated from the French edition (Paris, 1686) by H. A. Hargreaves.

**Creation or Evolution.** Correspondence on the Current Controversy. Edward O. Dodson and George F. Howe. University of Ottawa Press, Ottawa, 1990. xvi, 177 pp. \$27.59; paper, \$17.95.

**The Decline and Fall of Hemispheric Specialization.** Robert Efron. Erlbaum, Hillsdale, NJ, 1990. xvi, 117 pp., illus. \$19.95.

**Deducing Function from Structure.** Fritiof S. Sjöstrand. 2 vols. Vol. 1, A Different View of Membranes. xviii, 475 pp., illus. \$105. Vol. 2, Information Processing in the Retina. xiv, 233 pp., illus. \$69.96. Academic Press, San Diego, CA, 1990.

**Editor's Choice: Smithsonian.** An Anthology of the First Two Decades of Smithsonian Magazine. Smithsonian Books, Washington, DC, 1990. 304 pp., illus. \$35.

**Emergency Psychiatry.** Juan E. Mezzich and Ben Zimmer, Eds. International Universities Press, Madison, CT, 1990. xxvi, 457 pp., illus. \$57.50.

**Environmental Restoration and Waste Management.** Five-Year Plan Fiscal Years 1992–1996. U.S. Department of Energy, Washington, DC, 1990 (avail-